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**Initial Graphics Exchange
Specification (IGES):
Procedures for the NIST IGES
Validation Test Service**

**Jacki A. Schneider
Lynne S. Rosenthal**

U.S. DEPARTMENT OF COMMERCE
Technology Administration
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Gaithersburg, MD 20899

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ABSTRACT

In 1989, the American Society of Mechanical Engineers (ASME) and the American National Standards Institute (ANSI) adopted the Initial Graphics Exchange Specification (IGES) Version 4.0 as a national standard (ASME/ANSI Y14.26M - 1989, Digital Representation for Communication of Product Definition Data). Subsequently, ASME/ANSI Y14.26M was adopted by the Federal Information Processing Standard Publication (FIPS PUB) 177 and the Continuous Acquisition and Life-Cycle Support (CAL S) specification, MIL-D-28000.

The Initial Graphics Exchange Specification (IGES) standard was designed to enable the compatible exchange of product definition data used by dissimilar computer-aided design and computer-aided manufacturing (CAD/CAM) systems. Utilizing a neutral database format, the IGES processor can create or translate 2-D and 3-D vector-based digital product model data.

This document provides general procedures for the National Institute of Standards and Technology's (NIST) IGES Validation Test Service. The NIST IGES Validation Test Service provides a way of determining the degree to which an implementation conforms to the FIPS PUB 177, which adopts the ANSI standard in its entirety. The NIST IGES Validation Test Service also provides a way of determining the degree to which an implementation conforms to the Continuous Acquisition and Life-Cycle Support (CAL S) specification, MIL-D-28000, Class II subset. The goal of the NIST Validation Test Service is to maximize the probability of successful data exchange between dissimilar CAD/CAM systems.

Conformance testing presents a functional and fiscal advantage to the vendor and end user. The end user will be provided with increased product confidence and portability that will expand freedom in the marketplace. The vendor will benefit from the test service by providing a validated product, thus stimulating sales to both government and industry.

The document is divided into two testing programs: preprocessor and postprocessor testing. In order to take into account the differences among the testing programs, many procedures have been tailored to the specific testing program. The procedures presented in this document are organized into four sections: an introduction, general procedures, and specific procedures for the two testing programs.

Keywords

Conformance testing, Continuous Acquisition and Life-Cycle Support (CAL S), Initial Graphics Exchange Specification (IGES), preprocessor, postprocessor, validation.

1 Introduction

1.1 Purpose

The testing of Initial Graphics Exchange Specification (IGES) files to determine the degree to which they conform to the federal standards may be required by government departments and agencies in accordance with Federal Information Resources Management Regulation (FIRMR) 201-20.303, 201-20.304, 201-39.1002, the associated Federal ADP and Telecommunication Standards Index, and as specified by the Federal Information Processing Standard Publication (FIPS PUB) 177.

As part of its mission, the Computer Systems Laboratory (CSL) at NIST provides a validation test service for the FIPS PUB 177 in support of government agencies' procurement requirements. The IGES Validation Test Service for FIPS PUB 177 that verifies the basic concepts and geometry of the IGES data files are correctly implemented; as such, it provides an effective means of assessing the fundamental capabilities of IGES processors. Moreover, CSL has been tasked by the Continuous Acquisition and Life-Cycle Support (CALS) and Electronic Commerce/Electronic Data Interchange (EC/EDI) office to establish an IGES Validation Test Service for MIL-D-28000, Class II subset. The IGES Validation Test Service for MIL-D-28000, Class II subset tests a specific set of IGES data files utilized in a particular application area.

NIST/CSL offers IGES validation testing programs for preprocessors and postprocessors to determine the degree of conformance to FIPS PUB 177 and/or MIL-D-28000, Class II (Engineering Drawings) subset. In order to take into account the differences between the preprocessor and postprocessor testing programs, many procedures have been tailored to the specific program. Thus, the procedures presented in this document are organized into four sections.

- Section 1, introduction
- Section 2, those that apply to the IGES validation test service as a whole
- Section 3, those that apply to the preprocessor testing program
- Section 4, those that apply to the postprocessor testing program

1.2 The IGES standard

Due to an expanding market of CAD/CAM systems and the incompatibility between those systems, it became necessary to develop a standardized exchange format to maintain data

integrity. The IGES/PDES Organization (IPO), a voluntary standards body comprised of members from industry, academia, and government, developed the IGES standard. The standard specifies file structure and syntactical definition, and defines the representation of geometric, topological, and nongeometric product definition data. The IPO, an accredited American National Standards Institute (ANSI) committee, continues to evaluate, maintain, and enhance the IGES standard.

In 1989, the American Society of Mechanical Engineers (ASME) and ANSI adopted IGES Version 4.0 as a national standard (ASME/ANSI Y14.26M - 1989, Digital Representation for Communication of Product Definition Data). Subsequently, ASME/ANSI Y14.26M was adopted by the Federal Information Processing Standard Publication (FIPS PUB) 177 and the Continuous Acquisition and Life-Cycle Support (CALS) specification, MIL-D-28000.

FIPS PUB 177 addresses IGES implementation, acquisition, interpretation, and conformance. It includes conformance requirements for processors as well as data files. MIL-D-28000 defines 5 classes of data by application area (i.e., subset or application protocol) and limits the use of IGES entities to those in the specified class. The primary objective of MIL-D-28000 is to accelerate the operation, exchange, and standardization of digital information systems acquisition and support.

1.3 Scope of validation

Validation is the process of testing an implementation for conformance to a specific standard. In particular, current IGES validation is the testing of the processor for conformance to the IGES standard. If compliance is demonstrated, a Certificate of Validation is issued.

Conformance testing of data exchange processors is, of necessity, in two parts: one for the preprocessor (writing) and another for the postprocessor (reading). The concentration for preprocessors is on the IGES files representative of the native CAD/CAM (*herein, CAx is used as a generic reference*) database. For postprocessors, the concentration is on the product definition data as it resides in the native CAx database.

The Validation Test Service for FIPS PUB 177, tests the most commonly implemented entities of the IGES standard. This approach was taken since there are over 180 entities and forms of entities within the IGES standard and no known CAx database supports them all. The Test Service for CALS, Class II subset, tests all the entities within the subset (see Appendix A for Test Service coverage). The reader should note that FIPS PUB 177 does not require the preprocessor or postprocessor to support all the entities within the specification. Similarly, MIL-D-28000 does not require the preprocessor to support all entities. However, the postprocessor is required to support all entities in the specified subset.

The method used for testing is called falsification testing. This method attempts to find errors in a candidate's implementation to determine if it is incorrect. A finite number of test cases are

used to test as many of the requirements of the standard as are feasible. If errors are found, the Implementation Under Test (IUT) does not conform to the standard. However, the absence of errors implies either the IUT conforms to the standard or the test suite was not comprehensive enough to find the errors.

The IGES Validation Test Service ensures the basic concepts and geometry of IGES are correctly implemented by focusing on single entity testing; as such, it provides an effective means of assessing the fundamental capabilities of IGES processors. Moreover, single entity testing provides the specificity needed to determine whether a vendor meets the indicated claims and facilitates error checking by the testing laboratory.

1.4 Definitions

The following terms are used throughout this document.

Certificate of Validation — a certificate that acknowledges compliance of an implementation to a FIPS PUB or military specification.

Client — anyone requesting conformance testing.

Compliance — the state of the implementation for which correct test results were obtained using the applicable version of the test suite.

Computer system environment or operating environment — the combination of computer hardware, software, CAX system, etc., used during the testing process.

Conformance testing — the tests to evaluate the adherence or non-adherence of an implementation under test (IUT) to a standard.

Control board — the body of IGES and/or validation experts who resolve disputes concerning the correctness of the test suite with respect to the IGES standard.

Implementation — the preprocessor or postprocessor is the implementation.

Implementation Under Test (IUT) — the preprocessor or postprocessor under test.

Postprocessor — a program which translates a file of product definition data from the database form of a specific CAX system defined by the IGES standard into the database form of a specific CAX system.

Preprocessor — a program which translates a file of product definition data from the database form of a specific CAX system into the form defined by the standard.

Protocol Implementation Conformance Statement (PICS) — a statement made by the Client, stating which entities/features of IGES, within the IGES Conformance Testing scope have been implemented.

Protocol Implementation eXtra Information for Testing (PIXIT) — a statement made by the Client, which contains or references all of the information (in addition to that given in the PICS) related to the IUT and its testing environment, which will enable the Laboratory to run an appropriate IGES Test Suite against the IUT.

Registered Report — the Validation Summary Report (VSR), once all validation processing steps have been completed. As a Registered Report, the Validation Summary Report (VSR) is entered on the *Validated Products List (VPL)*.

System under test (SUT) — the combination of the IGES processor and the supporting computer system environment.

Test Laboratory — the laboratory performing the validation, in this case, NIST/CSL.

Validated Products List — the list published by NIST of computer products that have been validated for conformance to a specific FIPS PUB or military specification.

Validation — the process of testing for conformance.

Validation Summary Report (VSR) — the document which presents the test results and other information relevant to the tests.

Validation Test Software — a software test tool utilized by the Laboratory to verify data values against the specification results.

2 General procedures

2.1 Validation by testing

2.1.1 Overview

The process of validation by testing consists of a Test Laboratory conducting the conformance tests on a Client's implementation and reporting the results of that testing in a Validation Summary Report (VSR). For details of the testing process see section 3, Preprocessor testing program, and section 4, Postprocessor testing program.

When the validation procedures are followed and the VSR shows the implementation under test (IUT) demonstrated conformance to the standard and/or the military specification, then a Certificate of Validation is issued to the Client. Thus, a certificate is only issued if there are no errors detected by the validation process. For processors that have been tested and contain errors, a Registered Report without a certificate will be issued. Generally, a Client must receive a Certificate of Validation or Registered Report in order for the Client's implementation to be procured by federal agencies.

After processor testing is completed without errors a Certificate of Validation is issued, which is valid for two years. A Registered Report, without a certificate, is valid for one year.

2.1.2 Validation Test Software

NIST has licensed the CADDETC¹ IGES test method and tools to test to FIPS PUB 177 and/or MIL-D-28000, Class II subset. CADDETC, an accredited testing laboratory with the National Measurement Accreditation Service (NAMAS), developed the conformance test method for IGES. The results of testing produced from either the NIST or CADDETC Test Laboratory are mutually recognized. Vendors seeking an international marketing tool may utilize conformance testing from either laboratory.

The Processor Test Suite consists of questionnaires, the test specification, the IGES data files, and supporting documentation. The questionnaires and supporting documentation are used to collect information about the functionality supported by the Client's processor. The test specification provides instructions which when followed by the Client produce the requisite output (i.e., IGES files or CAX data model).

¹CADDETC, Arndale House, Headingley, Leeds, LS6 2UU, UNITED KINGDOM.

The Processor Test Suite as supplied to the Client by the Laboratory may be used only on systems owned by the Client at the location specified in the License Agreement. The Processor Test Suite and documentation may not be copied or transmitted by any means to another party.

2.1.3 Renewal of a Certificate of Validation

A Certificate of Validation may be renewed for additional years, if the following conditions are met:

1. The Client certifies no changes have been made to any component of the implementation.
2. The Client certifies any changes made in the supporting operating system do not alter the function or operation of the implementation.
3. The Validation Test Software and Processor Test Suite have not changed substantially since the last validation was performed.

2.1.4 Validation Summary Report (VSR)

The Validation Summary Report (VSR) is the test report presenting the results of the validation. The VSR contains information about the Client, validation test software, and test suite versions, as well as errors that may have been detected. Additionally, the VSR may contain other information gathered during the validation process.

A draft VSR and Notification of Conformance form is sent to the Client. The Client should review the report and return the signed notification form to NIST. Once the signed notification form is received, the VSR becomes final, is designated as a Registered Report, and is entered on the *Validated Products List*.

A VSR will be issued for all completed validations. Until the VSR is finalized, all information concerning the validation is considered to be confidential. If the Client does not wish to release the VSR information, the notification form should not be signed or returned to NIST. No further action regarding the validation will be taken.

2.2 Registration

2.2.1 Overview

The rationale for validation by registration is that an implementation may function identically on multiple computer system environments. As an alternative to NIST formally validating each and every environment, validation by registration allows the Client to self-test implementations on additional computer system environments. Validation by registration provides the Client a low cost method for testing these additional environments and registering them in the *VPL*.

Validation by registration is only available for Clients whose processor(s) have been formally validated by NIST or CADDETC.

The process of validation by registration consists of a Client conducting the conformance tests, evaluating the results, and sending the results to NIST for inspection. In order to perform the self-testing, the Client must have a copy of the latest version of the appropriate test suite and test software.

If the registration criteria are met, the additional environments are added to the *Validated Products Lists* as a registered environment. For details on the registration process, see section 4.4, Registration of preprocessor environments, and section 5.4, Registration of postprocessor environments.

All self-tested environments are subject to challenge by NIST and other interested parties (such as procuring federal agencies). If the NIST inspection reveals a self-tested environment does not behave in accordance with the submitted validation material, all entries in the *VPL* for self-tested environments dependent on the formally validated implementation are stricken.

2.2.2 Eligibility for registration

The computer system environments which may be registered include:

1. Other releases/versions of the same operating system.
2. Different models of the same manufacturer computer family (e.g., HP 9000 series model 825, 835, 850; or IBM 43xx, 30xx, 93xx).
3. Different micro-processor architectures from the same manufacturer, where binary executable compatibility has been maintained.
4. Re-badged or renamed hardware (i.e., same hardware sold under a different name). Note, there will be no additional fee for registering re-badged hardware.

2.3 Miscellaneous

2.3.1 Pricing

The IGES Validation Test Service validations are to be performed on a cost-reimbursable basis. Pricing information can be found in the following testing program sections or may be obtained by contacting the NIST IGES Validation Test Service.

2.3.2 Cancellation

Once the validation process has begun, the Client agrees to reimburse NIST/CSL for the expenses incurred in preparation or performance of the validation. In the event that NIST/CSL cancels the validation due to nonsupport by the Client or failure of the Client to perform in a reasonable manner, the Client agrees to pay NIST/CSL for all validation expenses.

2.3.3 Disputed and withdrawn tests

Questions regarding the interpretation of the standard and the validity of the tests should be forwarded to the Test Laboratory at NIST, along with associated rationale and detailed documentation. The Test Laboratory and the Client will attempt to resolve these issues informally. If no resolution is reached, the Test Laboratory will refer the question to the Control Board for a ruling.

The test results are not issued by the Test Laboratory until all outstanding disputes have been resolved by the Control Board. If the test is judged to be invalid, the offending test will be corrected or withdrawn, and the VSR altered to reflect the ruling.

2.3.4 Validated Products List (VPL)

NIST publishes on a quarterly basis, a list of validated products having a current Certificate of Validation and/or a Registered Report. The *Validated Products List* may be obtained by request from:

National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, VA 22151
Phone: (703) 487-4630
Order Number: PB93937303/AS

The *VPL* may be acquired using MOSAIC or FTP on the World Wide Web. The MOSAIC address is <http://speckle.ncsl.nist.gov/vpl/html/intro.vpl>.

To access the *VPL* using FTP:

Type: ftp speckle.ncsl.nist.gov (internet address is 129.6.59.2)
Login as user ftp
Type your email address preceded by a dash (-) as the password
Type: cd vpl
Type: binary
Type: get and the name of the file you want (e.g., graphics)

2.3.5 Documentation

The Test Laboratory will create and maintain a Client file consisting of the following documents:

- all completed forms,
- all correspondence, and
- a log of all material events occurring during the validation.

The Client file and validation materials will be retained for 6 months after the validation process is concluded. However, the VSR will be retained for a minimum of 2 years.

2.3.6 Publication

In general, NIST shall have the right to use all information gathered in the course of developing and administering a conformance testing program for any governmental purpose. Registered Reports completed by NIST shall be made available to the public upon request.

3 Preprocessor testing program

3.1 Objective

Preprocessor conformance testing focuses on testing an IGES preprocessor for conformance to IGES Version 4.0 as specified in the FIPS PUB 177 and/or the CALS specification, MIL-D-28000, Class II subset. The main objective of the preprocessor test method is to test whether the preprocessor can write a conforming IGES data file, which can then be correctly interpreted by the validation test software. If an error occurs during implementation testing, the implementation under test should have the ability to skip the error without aborting the program.

Preprocessors are tested in conjunction with a specific environment. The environment consists of the computer hardware, operating system, and other CAX software needed to support the IUT. The Certificate of Validation and/or Registered Report issued as a result of validation pertain only to the preprocessor and environment actually tested.

3.2 Testing steps

The validation process for preprocessor testing is a multi-step process conducted in three phases that is initiated by a Client's Request for Validation (see Figure 1).

1. Information Collection
2. Prevalidation
 - a. Test suite preparation
 - b. IGES file generation
3. Formal Validation
 - a. On-site validation
 - b. Test report summary
 - c. Notification of conformance
 - d. Certificate and/or Registered Report

In order to complete the testing process, a Client must have extensive knowledge of its product and the use of IGES.

1. Information Collection

The Client is provided with a questionnaire regarding the functionality of the IGES preprocessor to be tested. The completed questionnaire constitutes a *Protocol Implementation Conformance Statement (PICS)*, stating the level of support for the various IGES constructs, attributes, entities, and entity forms. The information gathered is used to select relevant tests from the IGES Test Suite, so that testing is carried out upon the entities and features supported by the IUT.

The *PICS* is reviewed for consistency and violations of the FIPS PUB 177 and/or the MIL-D-28000, Class II subset. All discrepancies are documented and resolved with the Client.

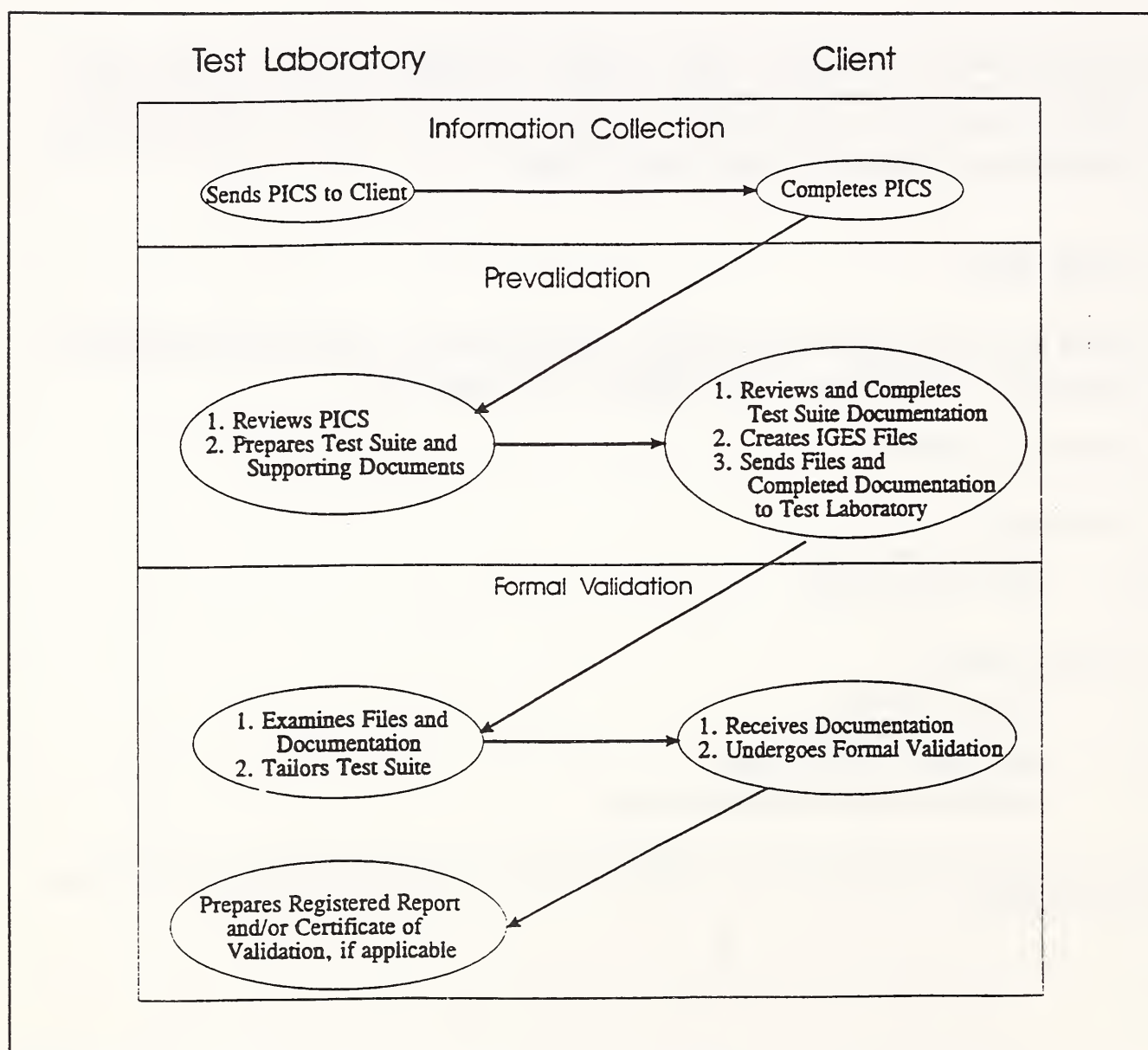


Figure 1

2. Prevalidation Phase

a. Test suite preparation --

Based upon the *PICS* responses, a Client-specific Test Suite is defined and prepared. The Test Suite consists of the test specification and supporting test documentation. The test documentation includes the: *Protocol Implementation eXtra Information for Testing (PIXIT)*, *Input Model and Reference Results*, and *Verdict Criteria*.

The *PIXIT* collects the CAX system representation and instructions for the creation of CAX constructs which correspond to the IGES entities and attributes. It also provides additional constraints (if any) on the CAX representation of the constructs.

The *Input Model and Reference Results* provide sufficient information for the CAX system operator to generate specific CAX models prior to the creation of the IGES files. Within the *Input Model and Reference Results*, tests using the same basic geometry or attributes have been grouped together to provide more concise documentation. For each test group there are two sections: the first defines one or more input models, which details the entity or attribute to be tested and provides sufficient information about the aspect under test; the second section gives one or more reference results, which provides selected part(s) of the resulting IGES file.

b. IGES file generation --

All tests require the generation of a complete and correct IGES file. Only the aspect under test will be examined for correct values; however, other information may be needed in order for the system to generate an IGES file. IGES files should be generated using the information supplied in the *Input Models and Reference Results* document within the context of a test.

Some IUTs may require modification to the test specifications. The Client must submit any proposed modifications to NIST for approval. All approved modifications shall be documented.

The Client submits the IGES data files and supporting documentation to NIST for prevalidation inspection. NIST will examine the files and supporting documentation and, with approval from the Client, will schedule the on-site validation. All discrepancies are documented and resolved.

3. Formal Validation

a. On-site validation --

The on-site validation consists of NIST personnel witnessing the creation of the IGES data files based upon the *Input Models*. The IGES files are then transferred (e.g., network or disk) to the NIST's personal computer system and evaluated against the *Reference Results* and *Verdict Criteria*.

Utilizing the Validation Test Software, the syntax of the file is tested as well as an efficient review of the IGES data according to its location, address, and field identities. The Validation Test Software allows for full and consistent checking of deviations in the database against the supported IGES specification features.

Utilizing the output from the Validation Test Software, information is gathered on the observed results and verdicts are generated. Intermediate verdicts are generated as sub-results in test case analysis as required by the test case verdict criteria. These intermediate verdicts contribute to a single test case verdict.

For each test case, all applicable verdict criteria shall be evaluated and verdicts of PASS, FAIL, or INCONCLUSIVE are to be assigned to each verdict criteria. A test case verdict shall be assigned based on the following:

- If any intermediate verdicts are FAIL, then a test case verdict of FAIL shall be assigned.
- If no intermediate verdicts are FAIL but at least one intermediate verdict is INCONCLUSIVE, then a test case verdict of INCONCLUSIVE shall be assigned.
- If no intermediate verdicts are FAIL but a visual presentation is required and not given, then a test case verdict of INCONCLUSIVE shall be assigned.
- If all intermediate verdicts are PASS, then a test case verdict of PASS shall be assigned.

The Test Laboratory and Client shall work to resolve an inconclusive verdict into a PASS or FAIL.

b. Test Report Summary --

NIST/CSL prepares a draft VSR summarizing the testing procedures and results of the preprocessor testing. The report includes information about the preprocessor (IUT) and the environment under which it was tested, the test specification, and all errors (behavior not in conformance with the standard, military specification, or test specification). Finally, the report clearly indicates whether or not the IUT meets the conformance requirements of the FIPS PUB 177 and/or MIL-D-28000,

Class II subset, and the functionality as claimed by the vendor in the test specification documents.

c. Notification of Conformance --

The draft VSR and the Notification of Conformance are sent to the Client. The Notification of Conformance lists the preprocessor and environment for which the certificate and final VSR will be issued. Additionally, any errors and/or conditionally supported capabilities will be identified.

The Client has 30 days to review the notification and draft VSR and contact NIST/CSL in writing of any objections. If there are no objections, the Client returns the signed Notification of Conformance. Receipt of this notification is required before the Certificate of Validation and final VSR can be issued. Note, the finalized VSR is designated as a Registered Report and issued as such.

d. Certificate of Validation and Registered Report --

A Certificate of Validation will be issued for preprocessors which have successfully passed the conformance requirements of the FIPS PUB 177 and/or MIL-D-28000, and meets the functionality as claimed in the test specification documents. A Registered Report, without a certificate, will be issued for preprocessors which have been tested and contain errors. The Certificate of Validation and/or Registered Report will be published in the *Validated Products List*.

3.3 Pricing

The cost for IGES preprocessor testing is as follows:

Preprocessor Pricing Table	
Validation	Registration
\$9,000 — base price	\$250 — for each environment (1 to 7)
\$600 — for each additional environment	\$2,000 — for 8 or more environments
\$6,000 — for each additional preprocessor	

3.4 Registration of environments

Clients whose preprocessors have been formally validated by NIST or CADDETC can register (i.e., list in the *VPL*) the preprocessor on other computer system environments based on the Client's self-testing.

Registration of preprocessor environments is applicable only if the preprocessor, when implemented on other computer system environments, is the same version number and does not require a recompilation of the processor.

To register a preprocessor for functioning on other computer system environments, the Client must submit a request for registration. The request must be made before the preprocessor's Certificate of Validation expires.

The Client performs the prevalidation step described above. Prior to submitting the IGES data files to NIST, the Client checks the files utilizing the Validation Test Software and verifies that the results are the same as the original IUT's IGES data files. The Client submits a signed statement along with the validation results (i.e., IGES data files) affirming the files are the result of executing the tests in the specified environment.

NIST inspects the validation results. If the preprocessor, when implemented on the additional environment, is functionally equivalent to the preprocessor implemented on the environment used during the validation by testing, then the environment will be registered in the *VPL*. Additionally, the Client's signed statement regarding the registered environment is added to the *VSR*.

4 Postprocessor testing program

4.1 Objective

Postprocessor conformance testing focuses on testing an IGES postprocessor for conformance to IGES Version 4.0 as specified in the FIPS PUB 177 and/or MIL-D-28000, Class II subset. The postprocessor (IUT) should be able to read an IGES data file and interpret that file correctly. It is essential for the IUT to overlook errors in translation without aborting the testing program.

Postprocessors are tested in conjunction with a specific environment. The environment consists of the computer hardware, operating system, and other CAx software required to support the implementation-under-test (IUT). The Certificate of Validation and/or Registered Report issued as a result of validation pertain only to the postprocessor and environment actually tested.

4.2 Testing steps

The validation process for postprocessor testing is a multi-step process conducted in three phases that is initiated by a Client's Request for Validation.

1. Information Collection
2. Prevalidation
 - a. Installation and interpretation of the requisite IGES files
 - b. Completion of test suite documentation
3. Formal Validation
 - a. On-site validation
 - b. Test report summary
 - c. Notification of conformance
 - d. Certificate and/or Registered Report

In order to complete the testing process, a Client must have extensive knowledge of its product and the use of IGES.

1. Information Collection

For testing to the FIPS PUB 177, the Client is provided with a questionnaire regarding the functionality of the IGES postprocessor to be tested. The completed questionnaire constitutes a *Protocol Implementation Conformance Statement (PICS)*, stating the level of support for the various IGES constructs, attributes, entities, and entity forms. The information gathered is used to select relevant tests from the IGES Test Suite, so that

testing is carried out upon the entities and features supported by the IUT. The *PICS* is reviewed for consistency and violations of the FIPS PUB 177.

All entities and features within the military specification subset must be supported when testing postprocessor conformance to the MIL-D-28000, Class II subset; therefore, a *PICS* is not required.

2. Prevalidation Phase

- a. Test Suite installation and interpretation --
Based on the *PICS* responses, the Client is provided with a Client-specific test suite. The test suite consists of a collection of executable IGES data files, and supporting documents that includes the: *Protocol Implementation eXtra Information for Testing (PIXIT)*, *Reference Results*, and *Verdict Criteria*. The Client copies the test files from the (NIST-supplied) disk to the Client's system. As each test file is executed by the IUT, the resulting model/database is then interrogated against the *Verdict Criteria*, and the output is compared to the *Reference Results*. A pass/fail or inconclusive decision is made for each test case based on the requirements described in the *Verdict Criteria*.
- b. Completion of Test Suite documentation --
The Client submits the completed *Reference Results*, *Verdict Criteria*, and *PIXIT* for prevalidation inspection. Upon completion of prevalidation, the schedule and arrangements for on-site validation are confirmed.

Any disputed tests are documented and resolved.

3. Formal Validation Phase

- a. On-site validation --
The on-site validation consists of NIST personnel witnessing the Client's installation and execution of a "new" copy of the test suite. The IGES files are then evaluated against the *Reference Results* and *Verdict Criteria*.

In order to ascertain whether or not the verdict criteria have been met, it is necessary to interrogate the CAX system database. Only the view of the CAX system database obtained by "listing" (i.e., not the internal representation) will be used for interrogation purposes. Additionally, some test cases require a visual verification of correctness. If the CAX system does not have the capability to graphically represent the IGES file, these tests will be marked accordingly (e.g., inconclusive verdict).

Any visual presentation produced by the postprocessor shall accurately and correctly represent the IGES constructs contained in the file and the CAx database. Visual presentations may be used to substantiate data validity.

During the different steps of the analysis phase, information is gathered on the observed results and verdicts are generated. Intermediate verdicts are generated as sub-results in test case analysis as required by the test case verdict criteria. These intermediate verdicts contribute to a single test case verdict.

For each test case, all applicable verdict criteria shall be evaluated and verdicts of PASS, FAIL, or INCONCLUSIVE are to be assigned to each verdict criteria. A test case verdict shall be assigned based on the following:

- If any intermediate verdicts are FAIL, then a test case verdict of FAIL shall be assigned.
- If no intermediate verdicts are FAIL but at least one intermediate verdict is INCONCLUSIVE, then a test case verdict of INCONCLUSIVE shall be assigned.
- If no intermediate verdicts are FAIL but a visual presentation is required and not given, then a test case verdict of INCONCLUSIVE shall be assigned.
- If all intermediate verdicts are PASS, then a test case verdict of PASS shall be assigned.

The Test Laboratory and Client shall work to resolve an inconclusive verdict into a PASS or FAIL.

- b. Test Report Summary --
NIST/CSL prepares a draft VSR summarizing the testing procedures and results of the postprocessor testing. The report includes information about the postprocessor (IUT) and the environment under which it was tested, the test specification, and all errors (behavior not in conformance with the FIPS PUB 177 and/or MIL-D-28000, Class II subset, or test specification). Finally, the report clearly indicates whether or not the postprocessor (IUT) meets the conformance requirements of the FIPS PUB 177 and/or MIL-D-28000, Class II subset, and the functionality as claimed by the vendor in the test specification documents.
- c. Notification of Conformance --
The draft VSR and the Notification of Conformance are sent to the Client. The Notification of Conformance lists the postprocessor and environment for which the Certificate of Validation and final VSR will be issued. Additionally, any errors and/or conditionally supported capabilities will be identified.

The Client has 30 days to review the notification and draft VSR and to contact NIST/CSL in writing of any objections. If there are no objections, the Client returns the signed Notification of Conformance. Receipt of this notification is required before the Certificate of Validation and final VSR can be issued. Note, the finalized VSR is designated as a Registered Report and issued as such.

- d. **Certificate of Validation and Registered Report --**
 A Certificate of Validation will be issued for postprocessors which have successfully passed the conformance requirements of the FIPS PUB 177 and/or MIL-D-28000, Class II subset. A Registered Report, without a certificate, will be issued for postprocessors which have been tested and contain errors. The Certificate of Validation and/or Registered Report will be published in the *Validated Products List*.

4.3 Pricing

The cost for IGES postprocessor testing is as follows:

Postprocessor Pricing Table	
Validation	Registration
\$8,000 — base price	\$250 — for each environment (1 to 7)
\$600 — for each additional environment	\$2,000 — for 8 or more environments
\$5,000 — for each additional postprocessor	

4.4 Registration of environments

Clients whose postprocessors have been formally validated by NIST or CADDETC can register (i.e., list in the *VPL*) the postprocessor on other computer system environments based on the Client's self-testing.

Registration of postprocessor environments is applicable only if the postprocessor, when implemented on other computer system environments, is the same version number and does not require a recompilation of the processor.

To register a postprocessor on other computer system environments, the Client must submit a request for registration. The request must be made before the postprocessor's validation expires.

The Client performs the prevalidation step described above. The Client shall read each data file, compare the resulting translation to the reference results and complete the verdict criteria. The Client submits a signed statement along with the reference results affirming that the validation results were obtained by executing the tests in the specified environment.

NIST inspects the validation results contained in the reference results. If the postprocessor, when implemented on the additional environment, is functionally equivalent to the postprocessor implemented on the environment used during the validation by testing process, then the environment will be registered in the *VPL*.

APPENDIX A

IGES ENTITY COVERAGE

The following table presents the IGES entities and forms which are covered (i.e., tested) by the NIST Validation Test Service. It also indicates (by 'X') the subset of FIPS PUB 177 and MIL-D-28000, Class II entities and forms of entities that are tested.

GEOMETRIC ENTITIES			FIPS PUB 177	MIL-D-28000
Entity #	FORM	Entity Name		
0		null		X
100		circular arc	X	X
102		composite curve	X	X
104		conic arc		
	0	determined by parameters	X	X
	1	elliptic	X	X
	2	hyperbolic	X	X
	3	parabolic	X	X
106		copious data		
	11	2D linear path	X	X
	12	3D linear path	X	X
	20	centreline through points		X
	21	centreline through circle centres		X
	31	section: solid		X
	32	section: solid pairs		X
	33	section: solid + dash		X
	34	section: solid quads		X
	35	section: solid + dash + solid		X
	36	section: dash		X
	37	section: solid + perpendicular solid		X
	38	section: solid + perpendicular dash		X
	40	witness line	X	X
	63	simple closed planar curve	X	X

Entity #	FORM	Entity Name	FIPS PUB 177	MIL-D-28000
108		plane		
	0	unbounded	X	X
	1	bounded		X
110		line	X	X
112		parametric spline curve	X	X
114		parametric spline surface	X	X
116		point	X	X
118		ruled surface		
	0	equal relative arc length		X
	1	equal relative parametric values		X
120		surface of revolution		X
122		tabulated cylinder		X
124		transformation matrix	X	X
	0	orthonormal rotate/translate	X	X
	1	orthonormal rotate - reflect/translate		X
126		rational B-spline curve		
	0	determined by parameters	X	X
	1	line		X
	2	circular arc		X
	3	elliptical arc		X
	4	parabolic arc		X
	5	hyperbolic arc		X
128		rational B-spline surface		
	0	determined by parameters	X	X
	1	plane		X
	2	right circular cylinder		X
	3	cone		X
	4	sphere		X
	5	torus		X

Entity #	FORM	Entity Name	FIPS PUB 177	MIL-D-28000
	6	surface of revolution		X
	7	tabulated cylinder		X
	8	ruled surface		X
	9	general quadric surface		X
130		offset curve		X
140		offset surface		X
142		curve on a parametric surface		X
144		trimmed parametric surface		X
ANNOTATION ENTITIES			FIPS PUB 177	MIL-D-28000
212		general note		
	0	simple note	X	X
	1	dual stack		X
	2	imbedded font change		X
	3	superscript		X
	4	subscript		X
	5	super- /sub-script		X
	6	multiple stack /left justified		X
	7	multiple stack /centre justified		X
	8	multiple stack / right justified		X
	100	simple fraction		X
	101	dual stack fraction		X
	102	imbedded font change / double fraction		X
	105	super- / subscript fraction		X
214		leader (arrow)		
	1	wedge	X	X
	2	triangle	X	X
	3	filled triangle	X	X
	4	no arrowhead	X	X
	5	circle	X	X

Entity #	FORM	Entity Name	FIPS PUB 177	MIL-D-28000
	6	filled circle	X	X
	7	rectangle	X	X
	8	filled rectangle	X	X
	9	slash	X	X
	10	integral sign	X	X
	11	open triangle	X	X
216		linear dimension		
	0	undetermined form	X	X
218		ordinate dimension		
	0	witness line and leader	X	X
220		point dimension	X	X
222		radius dimension		
	0	single leader format	X	X
	1	multiple leader format		X
228		general symbol		
	0	general symbol		X
	1	datum feature		X
	2	datum target		X
	3	feature control frame		X
230		sectioned area		
	0	standard crosshatching	X	X
DEFINITION ENTITIES			FIPS PUB 177	MIL-D-28000
304		line font definition		
	0	subfigure pointer		X
	1	repeating pattern		X
308		subfigure definition	X	X
314		color definition		X
STRUCTURE ENTITIES			FIPS PUB 177	MIL-D-28000
402		associativity instance		

Entity #	FORM	Entity Name	FIPS PUB 177	MIL-D-28000
	3	views visible		X
	4	views visible, colour, line weight		X
	7	unordered group without backpointers	X	X
404		drawing		
	0	translate and scale	X	X
406		property		
	1	definition levels		X
	3	level function		X
	15	name		X
	16	drawing size		X
	17	drawing units		X
408		singular subfigure instance	X	X
410		view		
	0	orthographic parallel	X	X
	1	perspective		X

